ECR ETCHING DEVICE

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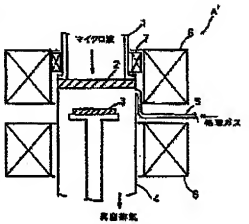
Abstract of **JP6005548**

PURPOSE:To make an etching configuration vertical to a sample and to reduce damage to the sample by arranging the sample in a central axial intermediate part of a coil group and by arranging an auxiliary coil concentrically with the coil group in an area near the coil group to change profile of a magnetic field. CONSTITUTION:A sample substrate 3 is arranged in a central axial intermediate part of magnetic coils 6, 6 and an auxiliary coil 7 is arranged concentrically with the magnetic coils 6, 6 inside the magnetic coils 6, 6. Magnetic field profile generated by the magnetic coils 6, 6 is changed by the auxiliary coil. That is, direction of magnetic force line from an ECR surface to the sample substrate 3 is made uniform to control movement direction of ion vertically to the sample substrate 3. Thereby, it is possible to maintain etching performance such as high etching velocity and high selectivity, to make etching configuration vertical to the sample substrate 3 and to reduce damage to the sample substrate 3.



PATENT ABSTRACTS OF JAPAN

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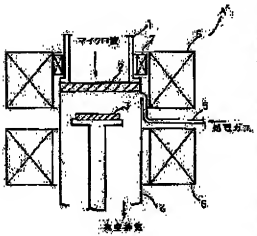
(54) ECR ETCHING DEVICE



(57)Abstract:

PURPOSE: To make an etching configuration vertical to a sample and to reduce damage to the sample by arranging the sample in a central axial intermediate part of a coil group and by arranging an auxiliary coil concentrically with the coil group in an area near the coil group to change profile of a magnetic field.

CONSTITUTION: A sample substrate 3 is arranged in a central axial intermediate part of magnetic coils 6, 6 and an auxiliary coil 7 is arranged concentrically with the magnetic coils 6, 6 inside the magnetic coils 6, 6. Magnetic field profile generated by the magnetic coils 6, 6 is changed by the auxiliary coil. That is, direction of magnetic force line from an ECR surface to the sample substrate 3 is made uniform to control movement direction of ion vertically to the sample substrate 3. Thereby, it is possible to maintain etching performance such as high etching velocity and high selectivity, to make etching configuration vertical to the sample substrate 3 and to reduce damage to the sample substrate 3.

CLAIMS

[Claim(s)]
[Claim 1]A magnetic field generating means which generates a magnetic field by sending current through a uniform direction at at least one pair of magnetic coil groups installed side by side, Have an electric field generating means which introduces microwave in a magnetic field generated by the above-mentioned magnetic field generating means, and generates an electric field, and by the above-mentioned magnetic field generating means. By an interaction of a magnetic field to generate and an electric field generated by the above-mentioned electric field generating means. In an ECR etching device which performs an etching process by irradiating a sample with Ion in raw gas plasma-ized using a electron cyclotron resonance phenomenon to produce, An ECR etching device which the above-mentioned sample is arranged to pars intermedia of the above-mentioned magnetic coil center-of-group shaft orientations, and forms an auxiliary magnet to which a profile of a magnetic field which is allocated in this magnetic coil group and the same mind near the above-mentioned magnetic coil group, and is generated by the above-mentioned magnetic field generating means is changed, and is characterized by things.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application]This invention relates to an ECR etching device, and relates to the ECR etching device used for manufacture of LSI etc. in detail.
[0002]
[Description of the Prior Art]In recent years, in manufacture of LSI etc., the ECR etching process method which is a lithography technology by a plasma reaction is used widely. The ECR etching device which performs an etching process, By the magnetic field and microwave. An etching process is performed by irradiating a sample substrate with the Ion in the raw gas plasma-ized using the electron cyclotron resonance (Electron Cyclotron Resonance, ECR) phenomenon produced by an interaction with the electric field to generate. The mimetic diagram and drawing 6 in which the outline composition in an example of ECR etching device A of the former [drawing 5] is shown are an explanatory view showing the line-of-magnetic-force profile in ECR etching device A, etc. As shown in drawing 5, in the conventional device A, microwave is introduced into the vacuum housing 4 into which the sample substrate 3 went from the microwave introducing window 2 which is oscillated from the microwave oscillator which is not illustrated and consists of quartz glass plates via the waveguide 1. Raw gas is introduced into the vacuum housing 4 from the raw gas feed port 5. A mirror magnetic field is impressed in the vacuum housing 4 by sending current through the magnetic coils 6 and 6 arranged so that this may be surrounded around the vacuum housing 4 in a uniform direction. As microwave, the 2.45-GHz thing which is generally industrial frequency is used. Therefore, the magnetic field intensity (magnetic flux density) which fulfills ECR conditions is set to 875G (gauss), and this field of 875G turns into an ECR surface where the maximum plasma density is obtained. Usually, in this kind of ECR etching device A, as shown in drawing 6, microwave is introduced from the high magnetic field side. That is, microwave is spread from the one where magnetic field intensity is larger than 875G, and plasma absorption is carried out in the place used as 875G. Then, the electron (e^-) by which it was generated rotates to the circumference of the right at right angles to a magnetic field, and exercises in the direction of a line of magnetic force. When an emission magnetic field as shown in drawing 6 is used, an electron (e^-) coils around a line of magnetic force, it exercises for an oblique direction, and Ion (+) exercises in the direction of the initial velocity. For this reason, an electric field occurs according to the charge separation of plasma which an electron (e-) and Ion (+) leave as it separates from a plasma generation place (ECR surface), and plasma is spread with an ExB drift. Therefore, it is irradiated to the sample substrate 3,

magnetic field intensity diffusing the charged particle (ion (+) and electron (e^-)) in plasma at **** by the above-mentioned emission magnetic field which becomes weak in the sample substrate 3 direction which separated a few from the ECR surface and has been arranged. The etching process of the sample substrate 3 is performed by this exposure. In this case, since electric charge particles are diffused by an emission magnetic field, the ion energy and the ion density which enter into the sample substrate 3 become small, and a high etch rate is not obtained. For this reason, the art which raises an etch rate is publicly known by impressing high frequency to the sample table with which the sample substrate 3 is laid, and giving a DC bias (JP,60-134423,A). These days, an ECR surface is formed near the sample table, and what was made to perform an etching process is developed, without impressing high frequency to a sample table (JP,3-259517,A).

[0003]

[Problem(s) to be Solved by the Invention]The following problems may be produced in conventional ECR etching device A which was described above.

** Since the emission magnetic field is used, a line of magnetic force may not enter vertically over the 3rd page of the whole sample substrate, but the side attachment wall etched in sample substrate 3 periphery may incline. Namely, since the movement directions of an electron (e^-) and ion (+) differ, The electric field which was in disorder according to charge separation of plasma occurs, the movement direction of ion (+) is disturbed by this and an etching configuration may serve as a back taper (phenomenon in which the pars basilaris ossis occipitalis becomes thin from the upper part of the etched pattern), by it (refer to drawing 7).

** In order to compensate the fall of the etch rate by using an emission magnetic field, in the thing impresses high frequency to a sample table and he is trying to raise an etch rate, there is a tendency for the selection ratio of etching objects, such as polysilicon, and grounds, such as silicon oxide (SiO2), to become small. For this reason, it is difficult to process an etching object selectively.

** In what formed the ECR surface in about three sample substrate, although a high etch rate and a high selection ratio are obtained, an ECR surface may shift to the high magnetic field or lower field side by movement of the electron (e^-) in plasma. Therefore, change of the etch rate by gap of the slight position of the sample substrate 3 is large, and tends to produce the problem of reproducibility. Microwave reached to the sample substrate 3, heat by microwave of the sample substrate 3 was carried out, and there was a possibility of giving a damage to the sample substrate 3 -- heating of the sample substrate 3 and the device on the sample substrate 3 receiving a damage.

Improving an ECR etching device and maintaining etching performances, such as a high etch rate and a high selection ratio, in order that this invention may solve the technical problem in such a Prior art. It aims at providing the ECR etching device which can make an etching configuration vertical to a sample, and can reduce the damage to a sample.

[0004]

[Means for Solving the Problem]To achieve the above objects, a magnetic field generating means which generates a magnetic field when this invention sends current through a uniform direction at at least one pair of magnetic coil groups installed side by side, Have an electric field generating means which introduces microwave in a magnetic field generated by the above-mentioned magnetic field generating means, and generates an electric field, and by the above-mentioned magnetic field generating means. By an interaction of a magnetic field to generate and an electric field generated by the above-mentioned electric field generating means. In an ECR etching device which performs an etching process by irradiating a sample with ion in raw gas plasma-ized using a electron cyclotron resonance phenomenon to produce, Arrange the above-mentioned sample to pars intermedia of the above-mentioned magnetic coil center-of-group shaft orientations, and. It is constituted as an ECR etching device which forms an auxiliary magnet to which a profile of a magnetic field which is allocated in this magnetic coil group and the same mind near the above-mentioned magnetic coil group, and is generated by the above-mentioned magnetic field generating means is changed, and is characterized by things.

[0005]

[Function]According to this invention, a sample is arranged in the pars intermedia of the magnetic coil center-of-group shaft orientations which constitute a magnetic field generating means, and an auxiliary magnet is allocated in this coil group and the same mind near the above-mentioned coil group, and the profile of the magnetic field generated by the above-mentioned auxiliary magnet by the above-mentioned magnetic field generating means is changed. That is, the direction of the line of magnetic force from an ECR surface to a sample can be arranged, and the movement direction of ion can be perpendicularly controlled to the above-mentioned sample. As a result,

the ECR etching device which can make an etching configuration vertical to a sample, and can reduce the damage to a sample can be obtained, maintaining etching performances, such as a high etch rate and a high selection ratio.

[0006]

[Example]It explains hereafter per [which materialized this invention with reference to the accompanying drawing] example, and an understanding of this invention is presented. The following examples are examples which materialized this invention, and are not the things of the character which limits the technical scope of this invention. The explanatory view and drawing 3 in which a magnetic field profile [in / in the mimetic diagram and drawing 2 in which the outline composition of ECR etching device A' which drawing 1 requires for one example of this invention is shown / ECR etching device A'] etc. are shown here the etching configuration of the sample substrate by ECR etching device A'. The section enlarged drawing and drawing 4 which are shown show the mimetic diagram showing the outline composition of ECR etching device A" concerning other examples of this invention. The same numerals are used for the element which is common in the mimetic diagram showing the outline composition in an example of the conventional ECR etching device A shown in said drawing 5. As shown in drawing 1, ECR etching device A' concerning this example, The point provided with the microwave oscillator (un-illustrating), the waveguide 1 and the microwave introducing window 2 equivalent to an electric field generating means, the vacuum housing 4 into which the sample substrate 3 equivalent to a sample was put, the raw gas feed port 5, and the magnetic coils 6 and 6 equivalent to a magnetic field generating means is the same as that of a conventional example. However, in this example, arrange the sample substrate 3 to the pars intermedia of the axis direction of the magnetic coils 6 and 6, and, The auxiliary coil 7 (equivalent to an auxiliary magnet) is allocated inside the magnetic coils 6 and 6 at the magnetic coils 6 and 6 and the same mind, and it differs from a conventional example in that the magnetic field profile generated by the magnetic coils 6 and 6 is changed with the auxiliary coil 7. In this example, a mainly different portion from a conventional example is explained, and since it is as the previous statement about the same portion as a conventional example, the detailed explanation is omitted. Hereafter, operation of etching device A' concerning this example is explained. A mirror magnetic field is impressed in the vacuum housing 4 by sending the exciting current same to a uniform direction through the magnetic coils 6 and 6 first. If the sample substrate 3 is arranged to the pars intermedia of the axis direction of the magnetic coils 6 and 6, the uniform magnetic field of 875G (gauss) will be formed near the sample substrate 3. Next, an about two-microwave introducing window magnetic field is made larger than 875G by energizing to the auxiliary coil 7. At this time, microwave is introduced in the vacuum housing 4 from the high magnetic field side, as shown in drawing 2, and it spreads the inside of plasma by the whistler wave transmitted in parallel with a magnetic field. And the high density plasma in which microwave is not reflected is formed. Namely, by generating plasma in the place (ECR surface) where magnetic field intensity became 875G, and forming a vertical and uniform line of magnetic force to the sample substrate 3 by the microwave introduced from the high magnetic field side, from an ECR surface to the sample substrate 3, The electronic (e^-) movement direction and the movement direction of ion (+) can be arranged. Therefore, charge separation of plasma [as / in a conventional example] does not produce the disordered electric field which was not generated but had been generated with the line of magnetic force of charge separation of plasma and an oblique direction, either. That is, the ion (+) which had a vertical movement ingredient to the sample substrate 3 can be generated so much. As a result, also in the state where the sample substrate 3 kept away from the ECR surface, and has been arranged, the etching process of etching objects (polysilicon etc.) can be performed with a high etch rate.

[0007]Since a high etch rate is obtained as selection ratios (silicon oxide etc.) for a ground even if it does not impress high frequency to a sample table, a high selection ratio is obtained. Since ion (+) enters vertically over the 3rd page of the whole sample substrate to the sample substrate 3 with a vertical line of magnetic force, vertical etching as shown in drawing 3 over the sample substrate 3 whole can be performed without an etching sidewall inclining in sample substrate 3 periphery. Since the sample substrate 3 is separated from the ECR surface, the damage to the sample substrate 3 by heat by microwave can be reduced. Drawing 4 is ECR etching device A" concerning other examples of this invention, and allocates auxiliary coil 7' near the sample substrate 3. Also in this case, like the above-mentioned example, the magnetic field profile by the magnetic field coils 6 and 6 can be changed by auxiliary coil 7', therefore the same effect as the above-mentioned example is done so. As mentioned above, in the magnetic field profile formed with the magnetic coils 6 and 6 and the auxiliary coil 7 (or 7'), Only vacuum housing 4 inner neighborhood of the microwave introducing window 2 is made into a magnetic field required for ECR conditions, and it applies to the sample substrate 3 from there, and is considered as the

magnetic field of uniform magnetic flux density lower than magnetic flux density required for ECR conditions. Therefore, conveying the electron (e^-) and ion (+) in the plasma generated in the ECR field to the sample substrate 3 along with a uniform line of magnetic force, and maintaining high density plasma, while ion (+) had had a vertical component, it enters into the sample substrate 3. As a result, maintaining etching performances, such as a high etch rate and a high selection ratio, an etching configuration can be made vertical to the sample substrate 3, and the damage to the sample substrate 3 can be reduced. Although the one auxiliary coil 7 (or 7') was formed in the above-mentioned example, on the occasion of actual use, both the auxiliary coil 7 and 7' may be provided, or two or more either may be provided. Thus, when two or more auxiliary coils are provided, a magnetic field profile can be changed more finely and the result accuracy of an etching configuration can be raised further. Although the auxiliary coil 7 (or 7') was formed inside the magnetic coils 6 and 6 in the above-mentioned example, even if it provides in the outside (however, neighborhood) of the magnetic coils 6 and 6 on the occasion of actual use, it is convenient in any way. Although the auxiliary coil 7 (or 7') was formed as an auxiliary magnet in the above-mentioned example, even if it provides a permanent magnet instead of an auxiliary coil on the occasion of actual use, it is convenient in any way.

[0008]

[Effect of the Invention]Since the ECR etching device concerning this invention is constituted as described above, in the magnetic field profile formed with a magnetic coil and an auxiliary coil, only the vacuum housing inner neighborhood of a microwave introducing window is made into a magnetic field required for ECR conditions, and it applies to a sample substrate from there, and is considered as the magnetic field of uniform magnetic flux density lower than magnetic flux density required for ECR conditions. Therefore, conveying the electron and ion in the plasma generated in the ECR field to a sample substrate along with a uniform line of magnetic force, and maintaining high density plasma, while ion had had a vertical component, it enters into a sample substrate. As a result, maintaining etching performances, such as a high etch rate and a high selection ratio, an etching configuration can be made vertical to a sample substrate, and the damage to a sample substrate can be reduced.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1]

The mimetic diagram showing the outline composition of ECR etching device A' concerning one example of this invention.

[Drawing 2]

The explanatory view showing the magnetic field profile in ECR etching device A', etc.

[Drawing 3]

The section enlarged drawing showing the etching configuration of the sample substrate by ECR etching device A'.

[Drawing 4]

The mimetic diagram showing the outline composition of ECR etching device A" concerning other examples of this invention.

[Drawing 5]

The mimetic diagram showing the outline composition in an example of the conventional ECR etching device A.

[Drawing 6]

The explanatory view showing the magnetic field profile in ECR etching device A, etc.

[Drawing 7]

The section enlarged drawing showing the etching configuration of the sample substrate by ECR etching device A.

[Description of Notations]

A' -- ECR etching device

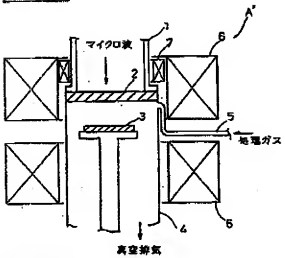
3 -- Sample substrate (equivalent to a sample)

6 -- Magnetic coil (equivalent to a magnetic field generating means)

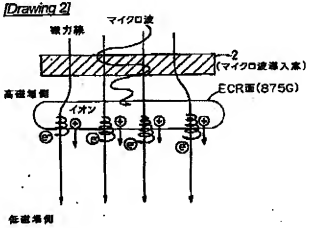
7 -- Auxiliary coil (equivalent to an auxiliary magnet)

DRAWINGS

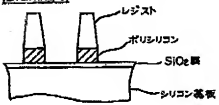
[Drawing 1]



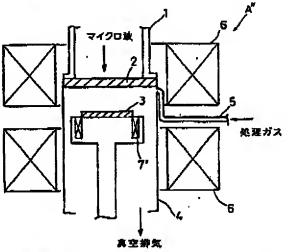
[Drawing 2]



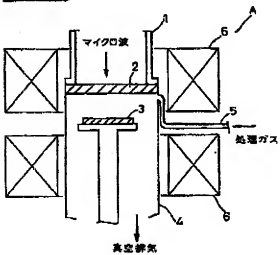
[Drawing 3]



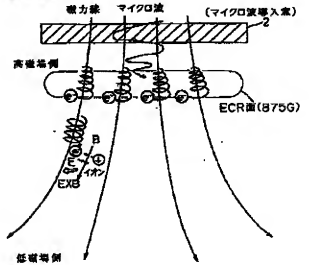
[Drawing 4]



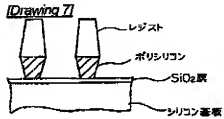
[Drawing 5]



[Drawing 6]



[Drawing 7]



PLASMA GENERATING DEVICE

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Publication date: 1999-03-30
Inventor: OKUMURA YUTAKA; SATO TAKASHI; TOKUMURA TETSUO; SEGAWA TOSHINORI; NOZAWA TOSHIHISA; ISHIBASHI KIYOTAKA; SHIGEYAMA KAZUKI
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- European:
Application number: JP19970250111 19970901
Priority number(s): JP19970250111 19970901

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Abstract of JP11087093

PROBLEM TO BE SOLVED: To provide a plasma of excellent quality by providing a magnetic member provided on a second mechanism side and fitted in a plasma generating space, and linearly extending the plasma generating space and the magnetic member along an adjacent surface to a plasma processing space. SOLUTION: A permanent magnet 25 is provided in a plasma generating chamber 21 side, and fitted in a plasma generating space 22, and linearly extended with the plasma generating space 22 along the adjacent surface of the plasma generating space 22 and the plasma processing space 13. Plural permanent magnets 25 and the plasma generating spaces 22 are alternately arranged in parallel with each other. Since the permanent magnets 25 are provided in both sides across the plasma generating space 22, four peaks of magnetism are formed in the periphery of the plasma generating space 22, and the plasma generating space 22 is formed with a basin of magnetism. With this structure, electron is sealed like a bar in a columnar or beam-like plasma generating space 22, and density of plasma is raised.